important modification of these theories. The proof of a very considerable antiquity rests upon the high and independent state of civilisation, which had been attained by the Mexicans and Peruvians at the time of the Spanish conquest, and the evidence that that civilisation had been preceded by several other stages of culture, following in succession through a great stretch of time, but the antiquity of the quasi-historical period thus brought out, is entirely thrown into the shade by the evidence now accumulating from various parts of the United States, Central America, and the Pampas, that man existed in those countries, and existed under much the same conditions of life, using precisely similar weapons and tools, as in Europe, during the pleistocene or quaternary geological period, and, perhaps, even further back in time. As in Europe his works are found associated with the remains of *Elephas primigenius*, and other extinct mammals, so in America are they found in contemporary deposits with those of *Elephas columbi*. If the inductions commonly made from these discoveries be accepted, and the fact admitted that men lived both in Europe and America before the surface of the earth had assumed its present geographical conformation, the data from which the problem of the peopling of America is to be solved are altogether changed. Recent palæontological investigations, especially those carried on with such great success in the neighbourhood of the Rocky Mountains, show that an immense number of forms of terrestrial animals that were formerly supposed to be peculiar to the Old World are abundant in the New; indeed many, such as the horses, rhinoceroses, camels, &c., are more numerous in species and varieties in the latter, and therefore the means of land communication between the two must have been very different to what it is now. Taking all circumstances into consideration, it is quite as likely that Asiatic man may have been derived from America, as the reverse, or both may have had their source in a common centre, in some region of the earth now covered with sea.

However this may be, the population of America has been for an immense period practically isolated from the rest of the world, except at the extreme north. Such visits as those of the early Norsemen to the coasts of Greenland, Labrador, and Nova Scotia, or the possible accidental stranding of a canoe containing survivors of a voyage across the Pacific or the Atlantic, can have had no appreciable effect upon the characteristics of the people.

The evidence derived from the study of the physical characters of the Americans shows that there is, considering the vast extent of the country they inhabit, and the great differences of climate and other surrounding conditions, a remarkable similarity in essential characters, with, at the same time much diversity in detail, and in other characters which perhaps are not of such primary importance as has often been thought. The construction of the numerous American languages, of which as many as 1,200 have been distinguished, is said to point to unity of origin, as, though widely different in many respects, they are all, or nearly all, constructed on the same general grammatical principle, that called *polysynthesis*, which differs from that of the languages of any of the Old World nations. In mental characteristics all the different American tribes have much that is in common, and the very different stages of culture to which they had attained at the time of the conquest, as that of the Incas and Aztecs, as contrasted with that of the hunting and fishing tribes, which has been quoted as evidence of diversity of race, were not greater than those between different nations of Europe, as Gauls and Germans, and Greeks and Romans in the time of Julius Cæsar; yet all these were Aryans, and in treating the Americans as one race, it is not intended that they are more closely allied than the different Aryan people of Europe and Asia.

The physical or anatomical characters of the American native people, taken as a whole (leaving out for the present the Eskimo), may be thus described:—In stature there is considerable variation. Among them are the tallest known people on the earth, the Tehuelches or Patagonians, who, though not the fabled giants of the early voyagers, appear, by all trustworthy accounts, to attain an average (for the men) of from 5 feet 10 inches to 6 feet, which exceeds that of any other race. Some of the North American Indians are also very tall, 381 Iroquois carefully measured during the late war giving a mean height of 5 feet 8·3 inches. On the other hand, the Fuegians, and especially the Peruvians, are small, the latter not averaging more than 5 feet 3 inches. There is, however, no pigmy race on the American continent, like the Bushmen, Negritos, and Lapps of the old world.

The hair, always a character of primary importance in zoological anthropology, is remarkably uniform. Its prevailing, if not universal, colour is black, or intensely dark brown. The pale and auburn colour of the hair of Peruvian mummies is probably due to accidental bleaching, and the fair hair, said occasionally to be met with in existing tribes, may be the result of European admixture. It is always straight and lank, though sometimes coarse and sometimes silky in texture, a variation dependant upon the thickness of the individual hairs. In transverse section it approaches the circular form, perhaps more nearly than in any other race, though in this and other characters it resembles that of the Asiatic Mongolian people. On the scalp the hair grows abundantly and often to a great length; in many North American Indians it has been known to trail upon the ground when standing upright. Not less characteristic is the rarity or absence of hair on the face and other parts of the body. The skin is smooth and soft, and of various shades of brown, though cinnamon (commonly called *copper* colour) is the most characteristic. Some Californian Indians and the now extinct Charruas of Uruguay were said to be nearly black; and some scattered tribes, both in North and South America, are described as being nearly as fair as Southern Europeans. The shade of the colour appears to have no relation to the external conditions, such as heat, moisture, &c. Though the features of various tribes, and of particular individuals in each tribe, show considerable diversity, a characteristic type prevails throughout the great majority of the whole people from north to south. The forehead is usually retreating; the face wide in the malar region, narrowing towards the chin; the brows prominent, overshadowing rather small, sleepy, half-closed eyes; the nose long from above downwards, and narrow; the dorsum, as seen in profile, usually arched, rather sunk at the root, then projecting somewhat horizontally, and making a tolerably sharp bend down to the tip, which is not produced down below the septum; though this form is very frequently met with among all tribes, there is some diversity, and the profile is sometimes simply arched and sometimes straight, but a broad flat nose is very rarely met with; the mouth is wide and prominent, the lips rather thin; the chin well formed, narrow, but prominent; the whole face below the eyes long and large, the malar bones projecting laterally, and the lower jaw large.

(*To be continued.*)

VARIATIONS FROM MARIOTTE'S LAW

THE universal application of the law enunciated by Mariotte and Boyle, that the "volume of an aëriform body is inversely as the pressure to which it is exposed," was brought into question at an early date after the publication of the famous experiments on which the principle was based. Oersted and Schwendsen established in 1826 for easily liquefiable gases that the elasticity does not keep pace with the pressure. At about the same

time Despretz showed that notable variations took place in the case of air above a pressure of fifteen atmospheres. Arago and Dulong, intrusted by the French Academy with the verification of these observations, carried out a carefully conducted series of experiments on the compressibility of air extending up to twenty-seven atmospheres, but came, however, to the conclusion that Mariotte's law was correct. This opinion was strengthened by Pouillet's researches in so far as it related to the then so-called permanent gases, while confirmatory evidence was brought in favour of Oersted and Schwendsen's experiments on easily liquefiable gases. This view of the correctness of the law for a certain group of gases was held by the scientific world until 1845, when Regnault, by a brilliant series of experiments of the most exact kind, showed that air, nitrogen, and carbonic acid experienced a constant decrease of elasticity when submitted to pressures rising to thirty atmospheres, while under the same conditions a regular increase of elasticity in the case of hydrogen occurred. A few years later Natterer of Vienna published some remarkable experiments on the compressibility of gases, making use for the first time of enormous pressures, reaching in several cases nearly 2,800 atmospheres. While Natterer's methods of measurement were by no means exact, the results of his experiments showed beyond doubt that for pressures above eighty atmospheres oxygen, nitrogen, and carbonic oxide possessed the same peculiar property manifested ordinarily by hydrogen, viz., the volume of the compressed gas being greater than that demanded by Mariotte's law. The verification of Natterer's

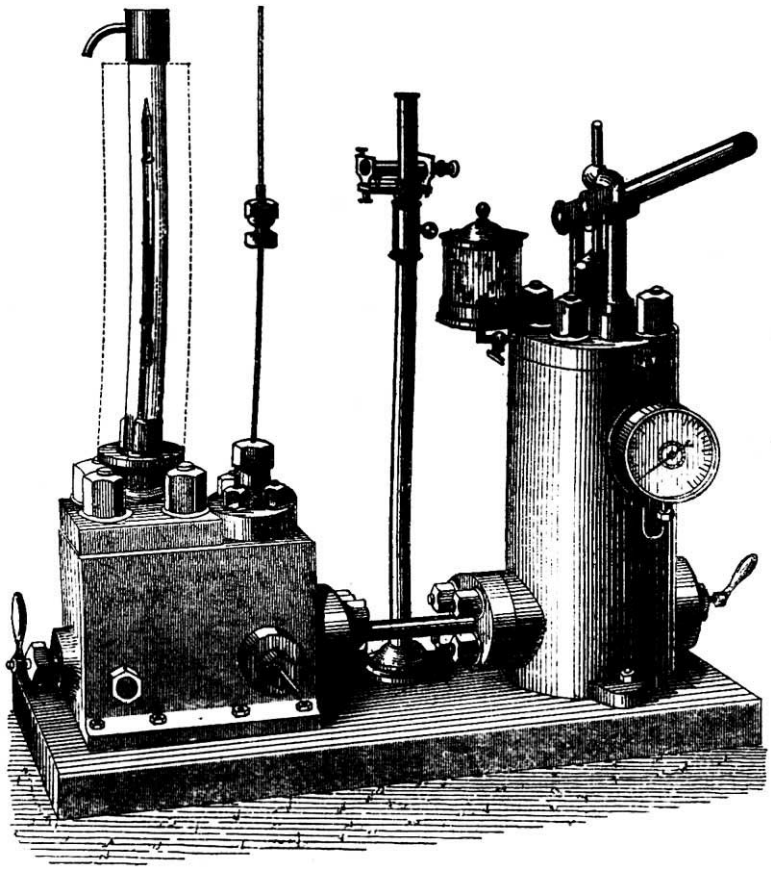

FIG. 1.

results was undertaken in 1870 by Cailletet, whose name has been so prominent of late years by his success in liquefying the so-called permanent gases. By making use of one of Desgoffe's manometers he experimented on air and hydrogen up to 600 atmospheres, and obtained figures comparing very closely with those published by Natterer.

So much for the data on this subject up to within a recent period. While the general truth of the results chronicled by Natterer and Cailletet was accepted by the physical world, it was still regarded as of prime importance to carry out the experiments under the influence of pressures with regard to the measurements of which there could be absolutely no doubt. The only practicable method of attaining this end was evidently to make use of enormously high columns of mercury. In 1875 Dr. Andrews attempted the solution of the problem in this manner, but was forced to succumb before the mechanical difficulties attendant upon its execution. The French physicist M. E. H. Amagat, who has devoted his attention for a number of years past to the phenomena of compressibility, appears to have been more successful in overcoming the manifold obstacles in the way of accomplishing the task, and furnishes [1] an interesting account of what is certainly one of the most remarkable *tours de force* of modern experimental physics. It consisted in making exact measurements of the changes in volume of gases when submitted to the pressure of a column of mercury of over *one-fifth of a mile* in height. In order to give a correct idea of the conditions under which Amagat's important results have been obtained, we will describe briefly the three essential elements of the experiments: the locality, the column of mercury, and the apparatus for receiving the pressures, communicating them to the gases operated upon, and measuring the

[1] *Annales de Chimie et de Physique* [5], xix. 345, Mars, 1880.

changes in volume. The latter (Figs. 1 and 2) consisted of a massive block of cast iron containing two cavities; one (C) for the reception of the extremity of the column of mercury, the second (D) for the reception of the graduated tube (M) inclosing the gas to be experimented upon. A narrow passage connects the two with each other and (F) with the reservoir of a powerful pump, while conical screw-taps (P′, P″) manipulated from the outside permit the openings into the cavity beneath the column of mercury or into the reservoir of the pump to be closed at will. The manometer (M) containing the gas to be compressed is of glass tubing, having an internal diameter of 1 millimetre and an external diameter of 10 millimetres, and is graduated for a distance of 50 centimetres. It is inserted hermetically into a massive bolt (B), which enters into the second cavity (D) of the apparatus. The free portion of the manometer is inclosed by a roomy glass tube, through which flowing water maintains a constant temperature, and that in turn by a copper cylinder, to guard against accidents. Mention can only be made

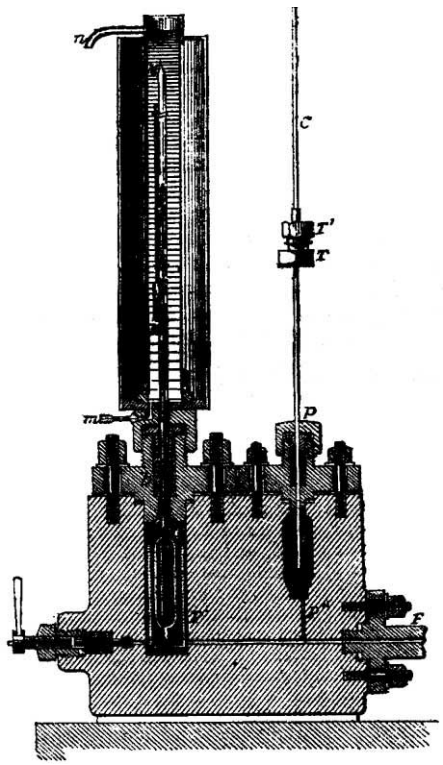

FIG. 2.

here of the ingenious devices for closing hermetically all the joints. The second important feature, the tube (C) for containing the column of mercury, is formed of pieces of steel tubing—internal diameter 2 millimetres, external 5 millimetres—united by specially prepared joints, which, while closing hermetically, are still easily attached or detached. The place chosen for the most noteworthy experiments was the coal-mine of Verpilleux, in the neighbourhood of St. Étienne. This pit reaches a depth of 327 metres, and a constant temperature prevails at the bottom.

The experiments made here were confined to nitrogen gas. The chief features of an experiment are as follows:—A vessel containing warm, dry mercury is placed in the large cavity (D) of the apparatus. The manometer containing dry pure nitrogen and terminating in a capillary point is then introduced beneath the mercury, the point is broken off, and the bolt inclosing the manometer is screwed into its place. Sections of the steel tubing (C) are then screwed on, one above the other. After the addition of each section mercury is forced into the apparatus by the pump, and mounts to the top of the tube; the height of the column of mercury is measured, the volume of the compressed gas is read off by means of a cathetometer, and thus the series of observations proceeds slowly until the mouth of the pit is reached. As can easily be imagined, such experiments in the shaft of a coal-pit are by no means easy or pleasant to perform. We can here allude only to the numerous elaborate precautions taken by M. Amagat to insure accuracy in measurement and reduce all possible causes of error to a minimum. The divergences in corresponding series of observations never exceeded one-tenth of 1 per cent.

Coming now to the results of the experiments made on the compressibility of nitrogen at Verpilleux, we notice, firstly, that the compressibility increases slowly until it reaches a maximum at about 65 atmospheres; secondly, that it decreases equally slowly until it reaches a normal figure at about 91 atmospheres; and thirdly, that after passing this point it decreases rapidly until at 430 atmospheres the volume of compressed gas is five-fourths of what it would be if Mariotte's law were true. In the following table the first column contains the pressures in atmospheres of the column of mercury, the second those deduced according to Mariotte's law from the corresponding volumes of compressed nitrogen, and the third the differences between the two:—

Pressures observed.	Pressures calculated.	Differences.
27·289	27·289	0·000
46·496	46·580	+ 0·084
62·034	62·251	+ 0·217
73·001	73·181	+ 0·188
80·580	80·728	+ 0·140
90·975	90·978	+ 0·003
109·171	108·665	− 0·506
126·896	125·388	− 1·508
168·810	162·835	− 5·975
208·635	196·224	− 12·411
251·127	229·271	− 21·855
290·934	256·669	− 34·275
332·039	282·544	− 49·495
373·302	306·055	− 67·247
430·773	335·707	− 95·066

After having established the above table of the changes in the compressibility of nitrogen, M. Amagat was in a position to study the analogous phenomena in the case of other gases with much greater ease. For this purpose it was simply necessary to replace the tube for the column of mercury in the apparatus just described by a manometer filled with nitrogen, the counterpart of that used for the gas under examination. By means of these modifications of his original apparatus M. Amagat has prepared very accurate tables for the changes in compressibility up to 400 atmospheres of air, oxygen, hydrogen, carbonic oxide, ethylene, and marsh gas. In M. Amagat's graphic delineation of the variations from Mariotte's law in the cases of the seven gases mentioned, the abscissæ correspond to the pressures in metres of mercury, while the ordinates correspond to the difference between the products of the pressures into the volumes and unity, *i.e.*, to the variations from Mariotte's law. They all start from a common point— a pressure of 24 metres. The curves of nitrogen and hydrogen are however continued to a minimal measure in accordance with Regnault's data. The minimum ordinate of the ethylene curve, which is 425, could not easily be given.

In glancing over the curves we see that the most conspicuous variations occur in the case of those gases most nearly approached to the conditions of liquefaction. The variations in the curve of oxygen are much more

marked than in that of nitrogen, while the curve of air lies between the two. Further, hydrogen is the only gas not exhibiting a minimum of the product of pressure and volume. As hydrogen is, so to say, the most perfect gas known, it would seem probable that on being forced to assume a state of tenuity allied to that of hydrogen, *i.e.*, by being exposed to elevated temperatures, the other gases experimented upon would yield curves resembling more and more that of hydrogen, until finally temperatures would be attained at which the convexity of the curves would totally disappear. The results chronicled by M. Amagat, taken in connection with those ascertained by other investigators in experimenting upon gases compressible at ordinary temperatures, would fairly allow the establishment of a law that when a gas on being compressed gives constantly increasing numbers for the product of the pressure by the volume—which according to Mariotte's law should remain unity—it is at a temperature above its critical point; or, to use Dr. Andrews' apt description, without actual liquefaction it can pass by means of pressure alone through all the intermediate stadia between the gaseous and the liquid states.

M. Amagat's interesting researches will, it is to be hoped, be followed by similar experiments executed under a wider range of temperature on the various gases; the results of which will, without doubt, throw much valuable light on the phenomena and conditions of liquefaction. Apart from their purely scientific interest, the tabulated records of his observations furnish to the engineer data of the greatest value, enabling him to construct manometers combining exactness and delicacy for the indication of high pressures, which hitherto have been measured with but a certain degree of approximation to the truth. T. H. N.

NOTES

DR. M. TREUB has been appointed director of the Botanical Gardens at Buitenzorg, Java.

WE are glad to learn that the collections from Socotra, which Prof. Bayley Balfour was compelled to send by sea from Brindisi, have arrived safely at Kew Gardens.

AT Dorpat a monument is about to be erected to the memory of the celebrated naturalist, Karl Ernst von Baer, who died at Dorpat on November 28, 1876. The funds will be supplied by the Dorpat University and the Imperial Academy of Sciences at St. Petersburg. The eminent sculptor, Herr Franz von Villebois, has made two excellent sketches for the monument.

AT a recent meeting of the Court of Common Council, at which the Lord Mayor presided, it was resolved that the freedom of the City of London in a suitable gold casket be presented to Sir Henry Bessemer, F.R.S., M.I.C.E., in recognition of his valuable discoveries, which have so largely benefited the iron industries of this country, and of his scientific attainments, which are well known and appreciated throughout the world.

ON August 5, as we have already announced, the exhibition of anthropological and prehistoric objects found in Germany will be opened at Berlin. At the same time the general meeting of the German Anthropological Society will take place. No less than 114 archæological, eight palæontological, and sixteen craniological museums will send objects to this exhibition. The objects found in the Loess strata will be particularly interesting, and besides these we may point to the objects found in caves and in moors.

THE British Medical Association will be well received at Cambridge in August, not only by the University but in the town; the Town Council have granted the Guildhall free of cost. The president of the Physiological Section, Dr. Rutherford, will give his address on Wednesday, August 11, at 2 o'clock, and there will follow a discussion on the subject, "Is Urea formed in the Liver?" to be opened by Prof. Gamgee, of Manchester; on August 12 Prof. W. Preyer, of Jena, will open a discussion on "Sleep and Hypnotism." Drs. Gaskell (Cambridge) and Stirling (Aberdeen) are the secretaries of this Section.

PROF. MILNE, of Tokei, Japan, who has made a trial of almost every seismoscope in existence, and has devoted all his leisure to seismometry for several years, has exerted himself successfully to interest the Japanese officials in establishing a suitable system of earthquake observation, as well as the Europeans in Japan, who have lately formed a society for the purpose of systematically studying seismic phenomena. Mr. Milne has obtained the assistance of the Government in having immediate telegraphic communication concerning earthquakes, and he aims at getting from telegraph operators throughout the country information concerning earth currents during earthquakes. If we consider the importance of studying the matter systematically in a country where small earthquakes occur every few days, and where the people are all greatly interested, it must be evident that this society will have a promising future.

A CONGRESS of the Members of the Royal Agricultural College, Cirencester, of former Students and Professors of the College, and of others interested in Agriculture, will be held in the College on Friday, June 4, 1880, under the Presidency of the Principal. At the Morning Session at 10 a.m. the subject for discussion will be—"Diseases in Cattle and Sheep, with especial reference to recent outbreaks," introduced by a paper by Prof. Buckman, F.G.S., F.L.S., on "The Natural History of Meadow and Pasture, in connection with such Diseases." At the afternoon session at 3 p.m. the subject for discussion will be—"Agricultural Research and Experimental Stations," introduced by Prof. Henry Tanner, M.R.A.C., F.C.S.

IN connection with the subject of "Fungus Inoculation of Insects," a Heidelberg correspondent, "O. S.," sends us for publication the following beautiful and little-known poem, by Goethe (1810, Poems, vol. ii.) :—

DER FLIEGENTOD

"Sie saugt mit Gier verräth'risches Getränke
Unabgesetzt, vom ersten Zug verführt;
Sie fühlt sich wohl, und längst sind die Gelenke
Der zarten Beinchen schon paralysirt;
Nicht mehr gewandt, die Flügelchen zu putzen,
Nicht mehr geschickt, das Köpfchen aufzustutzen—
Das Leben so sich im Genuss verliert.
Zum Stehen kaum wird noch das Füsschen taugen;
So schlürft sie fort und, mitten unterm Saugen,
Umnebelt ihr der Tod die tausend Augen."

DR. WERNER SIEMENS, the well-known German electrician, had been instructed, a few years ago, to manufacture a series of standard weights on behalf of the Egyptian Government, which wished to adopt] the German system; but as the Egyptian Government did not fulfil its financial obligations Dr. Siemens kept the set of weights in his workshop, where they were used for various purposes. On the occasion of the visit of the weights and measures inspector these weights were discovered, and Dr. Siemens summoned before the police. The case has been tried with some solemnity, and Dr. Siemens fined 2 marks.

A REMARKABLE phenomenon was observed at Kattenau, near Trakehnen (Germany), and in the surrounding district, on March 22. About half an hour before sunrise an enormous number of luminous bodies rose from the horizon and passed in a horizontal direction from east to west. Some of them seemed of the size of a walnut, others resembled the sparks flying from a chimney. They moved through space like a string of beads, and shone with a remarkably brilliant light. The belt containing them appeared about 3 metres in length and ⅔ metre in breadth.